REMARKS

In accordance with the foregoing, various of the claims are amended to improve form and claims 1, 5, and 7 are amended to clarify salient features of the invention. No new matter is presented and, accordingly, approval and entry of the amended claims are respectfully requested.

STATUS OF CLAIMS

All of the pending claims 1-7 are rejected for anticipation under 35 USC 102(e)* by Otawara (JP 11146306A), a reference cited in an IDS filed by applicants herein. *(It is believed that "§ 102(e)", instead, should be --§ 102(b)--.)

An English language translation of Otawara (paragraphs 0001 to 0011) is enclosed.

TRAVERSE OF THE CLAIM REJECTIONS

The rejection is respectfully traversed.

In the present invention, the number of bits for gray scale of output data is greater than the number of bits for gray scale of input video data which is provided to "the data converter." As a result and as shown in Fig. 5, 8 bit input video data is converted into 9 bit output data (SF0-SF8) by the data converter 50. The gray scale levels for 8 bit input data are 256, whereas the gray scale levels for 9 bit output data are 512. Therefore, the number of bits for gray scale of input video data is 8 bits (2^8=256); on the other hand, the number of bits for gray scale of output data is 9 bits (2^9=512).

The foregoing does not exclude--and, instead, generically encompasses--the embodiment of Fig. 10 of the present invention. According to Fig. 10, 8 bit input video data is converted into 11 bit output data (SF0-SF10) by the data converter. Further, the number of bits for gray scale of input video data is 8 bits (2^8=256); on the other hand, the number of bits for gray scale of output data is 9 bits (2^9=512). Although the number of sub-frames is 11 for the embodiment of Fig. 10, the number of bits for the gray scale of output data (512) is 9 bits.

According to the present invention, the gray scale levels of the output data are always greater than the gray scale levels of the input video data. Therefore, even though an image of one frame includes both darker and brighter portions within a common frame, the darker portion

is displayed with detailed gray scale levels and the brighter portion also is displayed with sufficient brightness, simultaneously.

On the other hand and as explained in the paragraph [0004], at lines 10-23 of page 2 in the English translation of Otawara, it is determined whether a signal for each subfield is noise, or not, and when a subfield consisting mainly of noise is detected, that subfield is changed into a subfield having a weighted value of 1/2 of the LSB (least significant bit). In Fig. 1 of Otawara, as explained in the paragraph [0008] spanning pages 3-4, A/D converter 1 converts an analog input video signal S1 into a digital output signal, and the subfield generator 3 generates a plurality of subfields from the converted digital output signal which is stored in the field memory 2. Further, in the paragraph [0009], lines 20-22 of page 4, there is a description "Thus, the subfield generator 3 is controlled in order to convert the pertinent subfield into a subfield SF 1/2 corresponding to bit 0, which is then displayed." That is, the subfield generator 3 converts the digital output signal stored in the field memory 2 into plural subfields, one of which is a subfield having a 1/2 weighted value, replacing a subfield with noise (i.e., a "subfield which primarily indicates noise" per Otawara § 0007, line 3). Therefore, the subfield generator 3 of Otawara may correspond to "a data cover" as in the present invention.

Although it is quite difficult to understand what "subfield of noise" means, Otawara appears to be addressing the typical situation in which the MSB of the digital signal is "0" for a large number of pixels in the same field. In this situation and according to Otawara, the MSB of the digital signal is changed, or converted, into a subfield having a 1/2 weighted value of the LSB. A second Otawara IDS citation, JP 11-95719, discloses a similar technology.

Therefore, as to similarities between the present invention and Otawara, in each case, the subfields or subframes include a subfield or a subframe having a weighted value smaller than the minimum gray scale level of luminance which is represented by the number of bits of the input video signal. In this regard, the "input video signal" of the present invention corresponds to the "digital signal output by A/D convert 1" in Otawara. However, the "data converter" of the present invention generates the output data, in which a number of bits for a gray scale of the output data is greater than a number of bits for a gray scale of the input video data, whereas "the subfield generator 3" of Otawara generates subfields whose number is the same as the number of bits of the digital output signal, which is provided to the subfield generator 3.

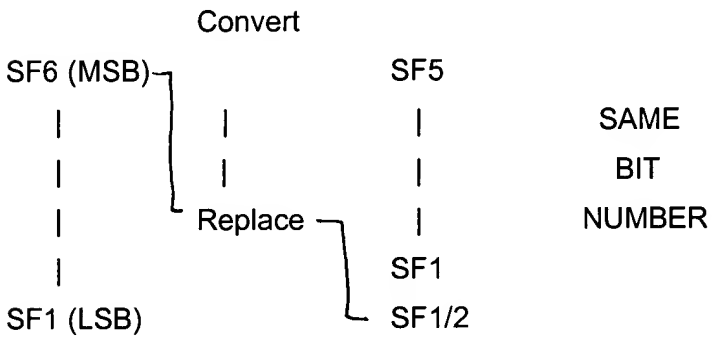
Thus, according to this distinction, in Otawara, when a picture of a certain field includes

only a darker picture and does not include a brighter picture, an MSB or a subfield with noise is replaced a subfield of 1/2. In Otawara, when the picture includes both a darker portion and a brighter portion, the MSB is not determined as a noise subfield, so that the MSB is not replaced the subfield of 1/2. In this situation, the darker portion is not displayed with detailed gray scale levels.

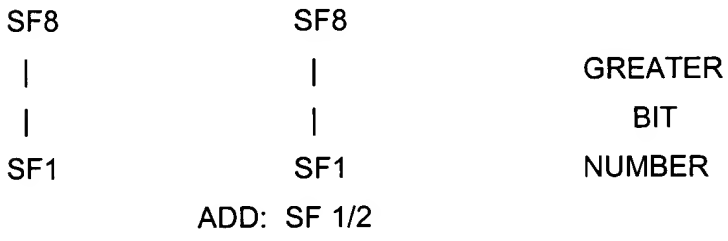
On the other hand, in accordance with the present invention, the data converter generates a digital output whose number of bits for gray scale is greater than the number of bits for gray scale of the input video data. That is, the data converter adds the subfield (or subframe) of 1/2 to the input data, and does not replace a certain field with noise a subfield (or subframe) of 1/2, as in Otawara. Therefore, even when the picture includes both a darker portion and a brighter portion, the data converter generates the subfield (or subframe) of 1/2 so as to display the darker portion with detailed gray scale levels while maintaining the brighter portion with sufficient brightness.

The difference may be diagrammed as follows:

Otawara



The Claimed Invention



CONCLUSION

In accordance with the foregoing, it is submitted that independent claims 1, 5 and 7 patentably distinguish over Otawara and at that the same should be withdrawn as a reference.

There being no other objections or rejections, it is submitted that the application is in condition for allowance, which action is earnestly solicited.

If there are any additional fees associated with filing of this Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,

STAAS & HALSEY LLP

Date: June 30, 2003

By: _____
H. J. Staas
Registration No. 22,010

700 Eleventh Street, NW, Suite 500
Washington, D.C. 20001
(202) 434-1500

[Detailed Description of the Invention]

[0001]

[Background of the Invention]

The present invention relates to a PDP display for increasing the gray scale level for a dark video image on a PDP (Plasma Display Panel) which displays a gray scale level using a subfield method.

[0002]

[Prior Art]

For a PDP for displaying data using pulse discharge, in order to provide a gray level display, such as a television video image, one field is divided into sub-fields corresponding to the individual bits of a digital video signal to be displayed, and pulse discharges are repeated in a number in proportion to the weight of each corresponding bit. While the number of gray levels can be increased by increasing the number of sub-fields, the scanning period for a displayed pixel is defined for each sub-field, so that display luminance is reduced. Therefore, when the consumption of power is constant, in principle there is a trade off between the number of displayed gray levels and the display luminance. Thus, while power consumption is also taken into consideration, it is difficult for an image, such as a television video image, the brightness of which is changed depending on time, to be presented on a screen at a satisfactory luminance and with more display gray levels. To obtain a satisfactory luminance without increasing the consumption of power, an insufficiency in the gray levels tends to occur,

especially on a dark video image which is visually remarkable.

[0003]

[Problems To Be Solved By the Invention]

To resolve the conventional shortcoming, it is one objective of the present invention to avoid the insufficiency in the gray levels on a dark video image which is visually outstanding, without increasing the power consumption or changing the maximum display luminance.

[0004]

[Means for Solving the Problems]

A PDP display device, which, in accordance with subfields corresponding to bits for the video signal to be displayed, provides a gray level display on a PDP (Plasma Display Panel) for a digital video signal, comprises:

noise determination means for determining whether a signal obtained for each subfield is noise; and

subfield drive sequence control means for displaying a subfield which is 1/2 of a subfield corresponding to the LSB (Least Significant Bit) of a video signal which is normally displayed,

wherein, when a subfield consisting mainly of a noise element is detected, the pertinent subfield is changed to a subfield having a weighted value 1/2 that of the LSB.

[0005]

Correlation detection means is provided for obtaining the correlation of fields for each subfield of the video signal, while the noise determination means determines whether the subfield, the correlation of which is equal to or smaller than

a predetermined value, is primarily a subfield for indicating noise.

[0006]

Common portion ratio calculation means is provided to calculate the ratio for the number of pixels in a common portion for fields or frames to the total number of pixels in each subfield, and a subfield, the common portion ratio of which is equal to or smaller than a predetermined value, is determined as a subfield mainly indicating noise.

[0007]

When for all the subfields the common portion ratio is equal to or smaller than the predetermined value, it is ascertained that there is no subfield which primarily indicates noise.

[0008]

The preferred embodiments of the present invention will now be described while referring to the drawings. Fig. 1 is a block diagram illustrating the essential portion of a PDP display device according to a first embodiment of the present invention. Fig. 2 is a timing chart of the subfields for a gray level display for the display apparatus. An A/D converter 1 converts an input video signal S1 into a digital video signal, and a subfield generator 3 prepares a subfield SF for which a lighting period is proportionate to the weight of each bit. When the number of bits for a normal display is, for example, 6 bits, from bit 1 (LSB) to bit 6 (MSB), one field of the video signal S1 is divided into six subfields, SF1 to SF6, which correspond to the individual bits. And each of the subfields SF1, SF2, . . . consists of an address period for scanning each discharge cell

in the PDP and a lighting period for an actual display discharge. For example, the subfield SF6, which corresponds to bit 6, consists of an address period SF6a and a lighting period SF6s. The lighting period for each subfield SF1, SF2, . . . is supposed to be proportionate to the weight of its corresponding bit. In accordance with the arrangement of the subfields, a drive unit 4 performs scanning, such as for forming a wall charge at a pixel which is to be turned on in a PDP 5 during each address period, and repeats the sustain discharge by the number of times which is proportionate to the lighting period. As a result, the video signal S1 is displayed on the PDP 5.

[0009]

For the bit 1 to bit 6 output by the A/D converter 1, i.e., for each subfield, a common portion ratio calculator 7a, under the control of the MPU 6, calculates the sum of the pixels in one field, and obtains the total number of display pixels. At the same time, the common portion ratio calculator 7a calculates the sum of the logical products of the output of the A/D converter 1 for bit 1 to bit 6 output by the field memory 2, i.e., calculates the total number of pixels displayed in common between the fields. The quotient obtained by dividing the total number of the common pixels by the total number of the display pixels is defined as the common portion ratio. Thereafter, a drive sequence control unit 7b compares the common portion ratio with a predetermined value, and when the common portion ratio is equal to or smaller than the predetermined value, it is ascertained that a corresponding subfield is one which primarily indicates noise. Thus, the subfield generator 3 is controlled in order to convert

the pertinent subfield into a subfield SF1/2 corresponding to bit 0, which is then displayed. If the common portion ratio for all the subfields is equal to or smaller than the predetermined value, it is ascertained that the original subfield is for a change in display screens, and that subfield is displayed unaltered.

[0010]

In a PDP display device according to another embodiment of the present invention, in the same manner as above, a correlation between fields is obtained, under the control of an MPU 6, for each subfield of a digital video signal obtained by an A/D converter, with a subfield having a correlation equal to or smaller than a predetermined value being defined as a subfield which primarily indicates noise and the pertinent subfield being converted into a subfield SF1/2, corresponding to bit 0, which is then displayed.

[0011]

[Advantages of the Invention]

A PDP display device, which, in accordance with subfields corresponding to bits of the video signal to be displayed using a PDP (Plasma Display Panel), provides a gray level display for a digital video signal comprises:

noise determination means for determining whether a signal for each subfield is noise; and

subfield drive sequence control means for displaying a subfield which is 1/2 of a subfield corresponding to the LSB (Least Significant Bit) of a video signal which is normally displayed,

wherein, when a subfield is detected which primarily includes a noise element, the pertinent subfield is changed to a subfield having a weighted value 1/2 that of the LSB. As a result, even when a bright image is to be displayed on the PDP, the gray level can be increased on a dark video image that is visually outstanding, so that an image having a superior image quality can be displayed.